FLOOR CARE APPARATUS
WITH DEEP CLEANING ACTION

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/397,573 filed July 22, 2002.

Technical Field

The present invention relates generally to the floor care field, and, more particularly, to a floor cleaning apparatus having a reversible rotary agitator for providing deep cleaning action for the nap of a rug or carpet being cleaned.

Background of the Invention

Upright floor care apparatus in all of their designs and permutations have become increasingly popular over the years. Upright vacuum cleaners, for instance, generally incorporate a nozzle assembly which rides on wheels over the floor surface to be cleaned and a canister assembly that is pivotally connected to the nozzle assembly. The canister assembly

includes an operating handle that is manipulated by an operator to move the vacuum cleaner to and fro across the floor. The canister assembly also includes a dirt collection vessel comprising either a bag-like filter or a dirt cup that may include a cyclonic separation chamber and filter combination. The dirt collection vessel traps dirt and debris while substantially clean air is exhausted by an electrically operated fan that is driven by an onboard motor. It is this fan and motor arrangement that generates the drop in air pressure necessary to provide the desired cleaning action.

In most upright vacuum cleaners sold today, a rotary agitator is also provided in the nozzle assembly. The rotary agitator includes tufts of bristles, brushes, beater bars or the like to beat dirt and debris from the nap of a carpet being cleaned while the pressure drop or vacuum is used to force air entrained with this dirt and debris into the nozzle of the vacuum cleaner. Powerhead assemblies for canister vacuum cleaners similarly include a nozzle assembly including a rotary agitator and a motor for driving the agitator as do extractors which have also become very popular in recent years. Extractors use a cleaning solution in combination with a rotary agitator for scrubbing action and a suction generator to draw off the dirt and solution from the carpet or rug being cleaned.

In all of these floor cleaning apparatus, it is desirable to provide still more efficient deep cleaning action. To achieve this end, the nap of the carpet or rug being cleaned should be scrubbed from the bottom to the top so that dust and dirt is continually moved up out of the carpet or rug. This is not achieved in state of the art floor cleaning apparatus where the

agitator is rotated in a single direction. As illustrated in Figure 7, the prior art agitator is rotated in a clockwise direction. Assuming the forward end of the floor care apparatus is to the right side of the drawing figure, it should be appreciated that the agitator is being driven in a rearward bottom-dead-center direction (note action arrow A). Accordingly, as the floor care apparatus is pulled rearward by the operator (note action arrow B), the agitator engages the nap of the carpet or rug being cleaned and scrubs dirt and debris upwardly from the bottom to the top of the nap (note action arrow C) where it may be drawn directly into the floor care apparatus and collected. Accordingly, good deep cleaning action is provided when the floor care apparatus is moved in the rearward direction.

In contrast, when the floor care apparatus is pushed forward away from the operator (note action arrow D), rotation of the agitator in the rearward bottom-dead-center direction serves to scrub dirt and debris downward along the nap from the top to the bottom (note action arrow E) thereby potentially grinding some dirt and debris into the jute J of the rug or carpet. Thus, it should be appreciated that when the floor care apparatus is moved in the forward direction, the desired deep cleaning action is no longer being provided.

The present invention addresses this shortcoming by reversing the drive direction of the agitator so that whether the floor care apparatus is being pushed forward or pulled rearward, the agitator is rotating in the necessary direction to provide efficient and effective deep cleaning action, i.e., dirt and debris are being scrubbed and brushed upwardly from the

bottom to the top of the nap and into the airstream being drawn into the floor care cleaning apparatus.

Summary of the Invention

In accordance with the purposes of the present invention as described herein, an improved deep cleaning floor care apparatus is provided. The floor care apparatus may take the form of an upright vacuum cleaner, a canister vacuum cleaner with a powerhead, or even an extractor. The floor care apparatus includes a cannister assembly, a suction generator, and a nozzle assembly. The nozzle assembly includes a housing that defines an agitator cavity, an agitator mounted in the agitator cavity for rotation in a forward bottom-dead-center direction and rearward bottom-dead-center direction, and a drive motor for driving the agitator in either the forward or rearward direction. In addition, an actuator for controlling operation of the drive motor and rotation direction of the agitator may be carried on either the cannister assembly or the nozzle assembly.

As a result, as the agitator is pushed or pulled through the nap of the underlying carpet or rug, the agitator is rotating in the necessary direction to provide efficient deep cleaning action so that the nap is brushed and scrubbed from the bottom toward the top and dirt and debris is directed by the agitator up out of the carpet or rug and into the airstream being drawn into the floor care apparatus by the suction generator. That dirt and debris is then trapped in the dust collector resulting in a cleaner carpet or rug.

In one embodiment, for example, a moveable hand grip is slidably mounted to a control handle for directing the forward and rearward rotation of the agitator and direction of movement of the nozzle assembly. As force is exerted on the hand grip by an operator, the hand grip slides along a stem of the control handle. A forward thrust moves the hand grip forward forcing the closure of a forward switch and the application of a voltage signal to a controller. Similarly, a reverse thrust exerted on the hand grip moves the hand grip rearward opening the forward switch and forcing the closure of a rearward switch and the application of a voltage signal to the controller. The status of the switches is monitored by the controller.

In accordance with another aspect of the present invention, the controller is programmed to drive the drive motor in either of the forward bottom-dead-center direction and the rearward bottom-dead-center direction upon receipt of a signal from the actuator. More specifically, the controller may be programmed upon a change of state of the actuator signal to remove power from the drive motor and to reapply power to the drive motor such that the agitator is rotated in a different direction. In one embodiment, the reapplication of power to the drive motor is delayed by the controller for between 0.1 second and 1.0 second to allow the agitator rotating in the forward direction to slow significantly, if not stop, before power is reapplied to drive the agitator in the rearward direction and vice versa. In addition, the power reapplied to the agitator drive motor may be incrementally increased using a ramp or step function, or the like, to a normal operating level in order to reduce arcing and inrush current peaks.

In accordance with the broadest teachings of the present invention, the floor cleaning apparatus described generally above may be an upright vacuum cleaner or extractor, or a canister type vacuum cleaner or extractor equipped with a powerhead incorporating a power driven agitator as are well known in the art. In either instance, the agitator drive motor may be positioned coaxially with the agitator including within the agitator. Alternately, the nozzle assembly may include a belt and pulley assembly or even a gear drive connecting a remotely positioned drive motor to the agitator as is also well known in the art.

In addition, the canister assembly in either instances, includes a collection vessel comprising either a bag-like filter or a dirt cup that may but does not necessarily have to include a cyclonic separation chamber and filter combination. The collection vessel traps dirt and debris while substantially clean air is exhausted by an electrically operated fan that is driven by an onboard motor. More specifically, the dust collector may take a number of forms including any type of dust cup, dirt cup or other container which is reusable and may be removed from the floor care apparatus to allow the dumping of dirt and debris into a garbage can or other waste receptacle. Of course, the dust collector may also take the form of a replaceable dust bag which is disposed in a garbage can when filled and replaced with a new bag as needed.

In accordance with another aspect of the present invention, a method of cleaning a nap of a carpet or rug using a floor care apparatus having a power driven agitator is provided. The method comprises the

steps of rotating the agitator in a forward bottom-dead-center direction as the floor care apparatus is pushed forward by an operator, and rotating the agitator in a rearward bottom-dead-center direction as the floor care apparatus is pulled rearward by an operator. In this way, the agitator is always rotating toward the direction of movement of the floor care apparatus at its bottom-dead-center position so as to provide more efficient deep cleaning action. Specifically, the nap of the carpet or rug being cleaned is always being brushed from the bottom toward the top so that the agitator is moving dirt and debris into the airstream being drawn into the floor care apparatus by the suction generator as shown in Figures 3a and 3b. The method may be alternatively described as including the steps of sensing operator input to determine a direction of desired nozzle assembly movement, and driving the agitator in a desired direction of the nozzle assembly movement.

In accordance with still another aspect of the present invention, a floor cleaning apparatus includes a nozzle assembly including an agitator cavity and at least one rotary agitator mounted for rotation in the agitator cavity. That rotary agitator is rotated in a first direction as the floor care apparatus is pushed forward by an operator and in a second direction as the floor care apparatus is pulled rearward by an operator. The floor cleaning apparatus also includes a cannister assembly connected to the nozzle assembly, a suction generator, a drive motor for driving the at least one agitator, and an actuator for controlling operation of the drive motor and rotation direction of the at least one agitator. In accordance with the broad

teaching of the present invention, the suction generator, the at least one agitator, and the drive motor may each be carried on one of the nozzle assembly and cannister assembly.

In the following description there is shown and described one possible embodiment of this invention, simply by way of illustration of one of the modes best suited to carry out the invention. As it will be realized, the invention is capable of other different embodiments, and its several details are capable of modification in various, obvious aspects all without departing from the invention. Accordingly, the drawings and descriptions will be regarded as illustrative in nature and not as restrictive.

Brief Description of the Drawing

The accompanying drawing incorporated in and forming a part of the specification, illustrates several aspects of the present invention, and together with the description serves to explain the principles of the invention. In the drawing:

Figure 1 is a perspective view of a floor care apparatus, in this instance an upright vacuum cleaner, constructed in accordance with the teachings of the present invention;

Figure 2 is a schematic block diagram showing the control circuit that controls the application of electrical power to the agitator motor depending upon the direction in which the floor care apparatus is being pushed or pulled by the operator;

Figures 3a and 3b are schematical views illustrating the present invention and, more particularly, how the agitator is driven depending upon the direction of movement of the floor care apparatus so as to provide the desired deep cleaning action whether that apparatus is being pushed forward or pulled rearward by the operator;

Figure 4 is a schematic block diagram showing an alternate embodiment of the present invention which utilizes a drive arrangement incorporating a belt and pulley assembly;

Figure 5 is a schematic block diagram showing another alternate embodiment of the present invention which utilizes a drive arrangement incorporating a gear drive assembly;

Figure 6 is a cross-sectional view through the nozzle assembly of the vacuum cleaner showing the agitator and agitator drive arrangement;

Figure 6a is a detailed cross-sectional view through the agitator; and

Figure 7 is a schematical view of the prior art showing the cleaning action of the agitator as the floor care apparatus is being pushed forward and pulled rearward by the operator.

Reference will now be made in detail to the present invention, an example of which is illustrated in the accompanying drawing.

Detailed Description of the Invention

Reference is now made to Figure 1 showing a preferred embodiment of a floor care apparatus 10 of the present invention. It should be appreciated that while an upright vacuum cleaner 10 is

illustrated, embodiments of the present invention also include different upright vacuum cleaners and extractors, and canister vacuum cleaners and extractors equipped with a powerhead incorporating a power driven agitator such as shown, for example, in U.S. Patent 6,148,474 which is owned by the assignee of the present invention and is incorporated herein by reference.

The upright vacuum cleaner 10 includes a nozzle assembly 16 and a canister assembly 18 pivotally connected to the nozzle assembly. The canister assembly 18 further includes a control handle 20 and a hand grip 22. A power switch 24 is provided for turning the vacuum cleaner on and off. Of course, electrical power is supplied to the vacuum cleaner 10 from a standard electrical wall outlet through a cord (not shown) as is known in the art.

In the present preferred embodiment, the hand grip 22 is slidably mounted to a stem 21 of the control handle 20. As forces are exerted on the hand grip 22 by an operator, the hand grip 22 slides along the stem 21 as shown by action arrows E in Figure 1. A forward thrust moves the hand grip 22 forward toward the cannister assembly 18 forcing closure of a forward switch 23 and the application of a voltage signal (Vcc) generated by a power supply (not shown) to a first pin of controller 27. Similarly, a reverse thrust exerted on the hand grip 22 moves the hand grip rearward away from the cannister assembly 18 opening the forward switch and forcing closure of a rearward switch 25 and the application of the voltage signal (Vcc) to a second pin of controller 27. Dependent upon the desired

direction of movement of the nozzle assembly 16 as indicated by the open/closed states of the forward and rearward switches 23 and 25, the voltage signal (Vcc) generated by a power supply (not shown) is selectively applied to the first or second pins of controller 27.

As shown in Figure 2, the controller 27 in turn generates an output signal (S1) which is applied to and directs the operation of relay 29 and agitator motor 40. In the present preferred embodiment, the electrical power is converted from AC to DC by converter 31. The DC power is applied to the agitator motor 40 through relay 29 such that the motor and agitator 38 are rotated as illustrated in Figure 3a in a forward bottom-dead-center direction (see action arrow F) when the nozzle assembly 16 is pushed forward (see action arrow G) or are rotated as illustrated in Figure 3b in a rearward bottom-dead-center direction (see action arrow H) when the nozzle assembly is pulled rearward (see action arrow I) depending upon the open/closed states of the switches 23 and 25.

Preferably, the controller is programmed to monitor the open/closed states of the switches 23 and 25 and to generate the output signal (S1) which operates relay 29 accordingly. The controller 27 is further programmed to remove the DC power provided through relay 29 to the drive motor 40 and to reapply power to the drive motor such that the agitator is rotated in a different direction upon a change in state of the switches 23 and 25. In other words, when the operator of the vacuum cleaner 10 desires to change the direction of movement of the vacuum cleaner 10 by actuating the hand grip 22, the controller 27 generates a

different output signal (S1) causing the removal and reapplication of DC power to the agitator motor 40 through relay 29.

In one preferred embodiment, the reapplication of power to the drive motor 40 is delayed by the controller 27 for between 0.1 second and 1.0 second to allow the agitator 38 rotating in the forward direction to slow significantly, if not stop, before DC power is reapplied to drive the agitator 38 in the rearward direction and vice versa. It should be noted that the DC power reapplied to the agitator drive motor 40 may be incrementally increased using a ramp or step function, or the like, to a normal operating level in order to reduce arcing and inrush current peaks.

A pair of rear wheels 26 (partially shown) are provided at a lower portion of the cannister assembly 18 and a pair of front wheels 27 are provided on the nozzle assembly 16. Together, these wheels 26, 27 support the vacuum cleaner 10 for movement across the floor. To allow for convenient storage of the vacuum cleaner 10, a foot latch (not shown) may function to lock the canister assembly 18 in an upright position as shown in Figure 1. When the foot latch is released, the canister assembly 18 may be pivoted relative to the nozzle assembly 16 as the vacuum cleaner 10 is manipulated to-and-fro to clean the floor.

In the present preferred embodiment, the canister assembly 18 includes a cavity adapted to receive and hold a collection assembly or vessel 12. A detailed description of the dust collection vessel 12 of the present preferred embodiment may be found in PCT Application

PCT/US01/47401, entitled Cyclonic Vacuum Cleaner with Filter and Filter Sweeper, filed November 13, 2001. Although described as accessible from the front of the vacuum cleaner 10 in the noted PCT application, the dust collection vessel 12 may likewise be accessible from the rear of the vacuum cleaner 10. In accordance with the broad teaching of the present invention, the dust collection vessel may alternatively include a bag-like filter to receive dirt and debris as is also well known in the art.

The canister assembly 18 further carries a suction generator or fan 33 and suction fan drive motor 34. Together, the suction fan 33 and its cooperating drive motor 34 function to generate a vacuum airstream for drawing air, dust, dirt and debris from a surface to be cleaned through the nozzle assembly 16 to the collection vessel 12. While the suction fan 33 and suction fan drive motor 34 are illustrated as being carried on the canister assembly 18, it should be appreciated that one or both could likewise be carried on the nozzle assembly 16 if desired.

The nozzle assembly 16 includes a nozzle housing 35 that defines an agitator cavity 36 that receives a rotating agitator 38. The agitator 38 shown is rotatably mounted in the agitator cavity 36 and driven by a motor 40 and cooperating gear drive 42. In the present preferred embodiment, the motor 40 and gear drive 42 are coaxial with and housed within the agitator 38 as is described in greater detail below (see Figures 6 and 6a). While the vacuum cleaner of the present preferred embodiment is described with the agitator motor 40 positioned coaxially with and held within the agitator 38, a remotely positioned motor 93 in either the nozzle

assembly 16 or the canister assembly 18 described above may utilize a drive arrangement incorporating a belt and pulley assembly 99 as shown schematically in Figure 4 and/or a gear drive assembly 97 as shown schematically in Figure 5 in any manner desired to drive an agitator 95.

In the illustrated vacuum cleaner 10, the scrubbing action of the rotary agitator 38 and the negative air pressure created by the suction fan 33 and drive motor 34 cooperate to brush and beat dirt and dust from the bottom of the nap of the carpet being cleaned to the top and then to draw the dirt and dust laden air from the agitator cavity 36 to the dust collection vessel 12. Specifically, the dirt and dust laden air passes serially through a suction inlet defined by the nozzle housing 35 and hose and/or an integrally molded conduit in the nozzle housing 35 and/or canister assembly 18 as is generally known in the art. Next, the dirt and dust laden air is delivered into the dust collection vessel 12 which serves to trap the suspended dirt, dust and other particles inside while allowing the now clean air to pass freely through to the suction fan 33 and ultimately to the environment through an exhaust port 50.

Reference is now made to Figures 6 and 6a which show the mounting of the agitator motor 40 and associated gear drive 42 coaxially with and within the agitator 38 in detail. As shown, the agitator 38 is mounted for rotation relative to the nozzle assembly 16. Specifically, a first end of the agitator 38 includes an end cap 52 which is supported on bearings 54 on a stub shaft 55 held in mounting block 56 keyed into slot 58 in the side of the nozzle housing 35. An end cap 60 at the opposite end of

the agitator 38 is supported on bearings 62 mounted on the housing 64 of the motor 40. As should be appreciated, the motor 40 is fixed to the nozzle housing 35 by means of the mounting block 66 fixed to the motor housing 64 and keyed in the slot 68 in the side of the nozzle housing.

The motor 40 drives a shaft 70 including gear teeth 72. The drive shaft 70 extends through a bearing 74 held in the hub 76 of the planetary gear set carrier 78. In the most preferred embodiment a fan 80 is keyed or otherwise secured to the distal end of the drive shaft 70.

The planetary gear set carrier 78 includes three stub shafts 82 that each carry a planetary gear 84. Each of the planetary gears 84 include teeth that mesh with the gear teeth 72 of the drive shaft 70. Additionally, the planetary gears 82 mesh with the teeth of an annular gear 86 that is fixed to the agitator motor housing 64 by pin or other means. Thus, it should be appreciated that as the drive shaft 70 is driven by the motor 40, the planetary gears 84 are driven around the annular gear 86, thereby causing the planetary gear set carrier 78 to rotate.

As best shown in Figure 6a, planetary gear set carrier 78 also includes a drive ring 88 and associated rubber drive boot 87 which includes a series of spaced channels 89 that receive and engage axial ribs 91 projecting inwardly radially from the inner wall of the agitator 38. Thus, the rotation of the planetary gear set carrier 78 is transmitted by the drive ring 88 and drive boot 87 directly to and causes like rotation of the agitator 38. The rubber drive boot 87 provides the necessary damping to insure the smooth transmission of power to the agitator 38.

Simultaneously with the rotation of the planetary gear set carrier 78 and agitator 38, the drive shaft 70 also drives the fan 80 at a ratio of between 4-1 to 10-1 and most preferably 6-1 with respect to the agitator 38. The resulting rapid rotation of the fan 80 helps to move air through the agitator 38 and ensure proper cooling of the agitator motor 40 during its operation.

In operation, the operator applies a force to the hand grip 22 dependent upon a desired direction of movement of the nozzle assembly 16. If the force exerted on the hand grip 22 is in a forward direction, the forward switch 23 is closed through contact with the hand grip and the voltage signal (Vcc) is applied to the first pin of controller 27. The controller 27 in turn generates an output signal (S1) based on the open/closed states of the switches 23, 25 which is applied to and directs the operation of relay 29. In the present scenario with a forward force applied to the hand grip 22, DC power is applied to the agitator motor 40 such that the agitator 38 is driven in the forward bottom-dead-center direction.

Conversely, if the force exerted on the hand grip 22 is in a rearward direction, the rearward switch 25 is closed through contact with the hand grip and the forward switch remains open or is opened. In response to the output signal (S1) of the controller 27, relay 29 operates to direct the DC power to the agitator motor 40 such that the agitator 38 is driven in a rearward bottom-dead-center direction.

Once the agitator 38 is rotating, a change in direction initiated by the operator, i.e., a change in the force exerted on the hand grip 22, is indicated to the controller 27 by the forward and rearward switches 23 and

25, respectively. If the agitator 38 is being driven in a forward bottom-dead-center direction and the operator exerts a rearward force on the hand grip 22, the hand grip travels along the stem 21 of the control handle allowing the forward switch 23 to open followed by the closure of the rearward switch 25. As the forward switch 23 opens, the voltage signal (Vcc) is removed from the first pin of controller 27 thus changing the controller input. As the rearward switch closes, the voltage signal (Vcc) is applied to the second pin of controller 27 again changing the controller input.

Based on the new states of the forward and rearward switches 23 and 25, the controller 27 stops generating the present output signal (S1) thus turning the relay 29 off and removing power from the agitator motor 40. The controller 27 may then generate a new output signal (S1) either immediately or after a delay period which actuates the relay 29 to direct the DC power to the agitator motor 40 such that the agitator 38 is driven in the rearward bottom-dead-center direction. The delay established by the controller 27 may be between 0.1 second and 1.0 second to allow the agitator 38 rotating in the first direction to slow significantly, if not stop, before DC power is reapplied to drive the agitator 38 for movement in the second direction and vice versa. In this manner, overheating of the agitator motor 40 may be substantially avoided.

The foregoing description of the preferred embodiment of this invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise

form disclosed. Obvious modifications or variations are possible in light of the above teachings. For example, various pressure sensing devices may be utilized to replace the forward and rearward switches which sense changes in direction initiated by an operator, or a single switch may be utilized to sense a change in direction with the agitator rotating in a normally forward bottom-dead-center direction.. Additionally, different delay timing patterns may be utilized during a stop, delay, and restart sequence or application of the DC power to the agitator motor 40 may be incrementally increased over a period of time. Even further, additional switching devices such as a FET array, for example, activated by the controller output signal may be utilized to direct the DC power to the agitator motor 40. The floor care apparatus could also be equipped with multiple agitators rather than a single agitator as illustrated.

The present embodiment was chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.